

NASA
Independent Verification & Validation Facility

Project Manager Handbook

[This Document is intended only as a guideline for use by the Independent Verification and Validation (IV&V) Facility (hereinafter referred to as "the IV&V Facility") PM personnel. The IV&V Facility's IMS policies/requirements and SLPs can be found at the IV&V Facility's IMS web site.]

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This document consists of several sections organized by specific topics. The following is the list of “champions” who are responsible for keeping this document current.

Sections	Champion
1. IV&V Tools Laboratory	Jeff Northey
2. IV&V Facility Research	Wes Deadrick
3. Financial Management & Earned Value	Markland Benson
4. Project Management Process, Facility intro & others	Raju Raymond

1 Purpose

The purpose of this handbook is to assist the new NASA IV&V Facility Project Manager (PM) staff to become familiar with the IV&V Facility and its project management processes. The PM Handbook outlines project management processes and procedures for software IV&V and Independent Assessment (IA) activities.

Specifically, the objectives of the PM Handbook are to provide the PM with an overview of:

- NASA and the IV&V Facility,
- The IV&V Facility quality management system,
- The project management process used at the IV&V Facility, including the financial management,
- The IV&V Facility's research program, and
- The tools available to support the projects.

2 Applicability and Scope

This document is primarily for educating the IV&V Facility's new PM staff. However, the handbook may be used as a reference material for all project management personnel.

3 Introduction to NASA and the IV&V Facility

3.1 *NASA Organization and History*

In 1915, the U.S. Congress established the National Advisory Committee for Aeronautics (NACA) "to supervise and direct the scientific study of the problems of flight, with a view to their practical solution." This became an enormously important Government research and development organization for the next half century, materially enhancing the development of aeronautics.

The National Aeronautics and Space Act of 1958 transformed NACA into the National Aeronautics and Space Administration (NASA) and gave it a broad mandate to "plan, direct, and conduct aeronautical and space activities"; to involve the Nation's scientific community in these activities; and to disseminate information about them widely. NASA became the preeminent organization in conducting aerospace research and development during the 1960s, even as it engaged in a broad-based space exploration program that included several diverse elements.

NASA began to conduct space missions within months of its creation, and during its 40-year history, it has had many scientific and technological accomplishments:

- Human space flight initiatives—Mercury's single-astronaut program (flights during 1961–63) to ascertain if a human could survive in space; Project Gemini (flights during 1965–66) with two astronauts to practice space operations, especially rendezvous and docking of spacecraft

and extravehicular activity (EVA); and Project Apollo (flights during 1968–72) to explore the Moon.

- Robotic missions to the Moon (Ranger, Surveyor, and Lunar Orbiter), Venus (Pioneer Venus), Mars (Mariner 4, Vikings 1 and 2), and the outer planets (Pioneers 10 and 11, Voyagers 1 and 2).
- Remote-sensing Earth satellites for gathering information (Landsat satellites for environmental monitoring); applications satellites for communications (Echo 1, TIROS, and Telstar) and weather monitoring.
- Skylab, an orbital workshop for astronauts.
- The Space Shuttle, a reusable spacecraft for traveling to and from Earth orbit.
- The International Space Station, enabling the scientific understanding necessary to explore the solar system.

The ultimate accomplishment of NASA during its first decade was Project Apollo and the landing of the first astronauts on the Moon on July 20, 1969. Following this accomplishment, NASA has developed the Space Shuttle and collaborated on the International Space Station, reached by the first crew in 2000.

The NASA's Vision –

To improve life here,
To extend life to there,
To find life beyond.

The NASA Mission –

To understand and protect our home planet,
To explore the universe and search for life,
To inspire the next generation of explorers,
...as only NASA can.

NASA Headquarters, located in Washington, D.C., manages the activities of the space flight centers, research centers, and other installations that constitute NASA. The following gives a brief description of the NASA constituents and a timeline of their establishment.

NASA Centers

TIME LINE

NASA Headquarters **Washington, DC 20546-0001** <http://www.hq.nasa.gov>

- Provide management for the agency
- Responsibilities include
 - Determination of programs and projects
 - Establishment of management policies, procedures, and performance criteria
 - Procedures, and Performance Criteria
 - Evaluation of Progress
 - The Review and Analysis of all phases of the aerospace program
- Organized into multiple program offices, which report to and receive overall guidance and direction from an associate or assistant administrator
- Six Strategic Enterprises include:
 1. Aerospace Technology ([Code R](#))
 2. Biological and Physical Research ([Code U](#))
 3. Earth Science ([Code Y](#))
 4. Human Exploration and Development of Space / Space Flight ([Code M](#))
 5. Space Science ([Code S](#))
 6. Exploration Systems ([Code T](#))

Langley Research Center <i>Hampton, VA</i>	1917
Jet Propulsion Laboratory <i>Pasadena, CA</i>	1936
Ames Research Center <i>Moffett Field, CA</i>	1939
John H. Glenn Research Center <i>Lewis Field in Cleveland, OH</i>	1941
Wallops Flight Facility <i>Wallops Island, VA</i>	1945
Dryden Flight Research Center <i>Edwards, CA</i>	1946
Goddard Space Flight Center <i>Greenbelt, MD</i>	1959
Marshall Space Flight Center <i>Huntsville, AL</i>	1960
Kennedy Space Center <i>Kennedy Space Center, Florida</i>	1961
Johnson Space Center <i>Houston, TX</i>	1961
Stennis Space Center <i>Stennis Space Center, MS</i>	1961
Goddard Institute Space Studies <i>New York, NY</i>	1961
White Sands Test Facility <i>Las Curcesk, New Mexico</i>	1964
Independent Verification & Validation (IV &V) Facility <i>Fairmont, West Virginia</i>	1993

Ames Research Center (ARC)
Moffett Field, CA 94035-1000

- Center for Excellence for Information Technology. This discipline area encompasses research in computer modeling and simulation, data base and information management, high-performance computing, networking and storage, software technology, smart sensor systems, artificial intelligence, and human factors.
- Established in 1939, as an aircraft research laboratory by the National Advisory Committee on Aeronautics (NACA) and in 1958 became part of NASA.
- <http://www.arc.nasa.gov>

Dryden Flight Research Center (DFRC)
Edwards, CA 93523-0273

- Since 1946, DFRC has conducted unique and highly specialized flight research programs.
- "Center of Excellence" for atmospheric flight operations. - NASA's primary installation for flight research
- <http://www.dfrc.nasa.gov>

Goddard Space Flight Center (GSFC)
Greenbelt, MD 20771-0001

- Established in 1959 and is named for Dr. Robert H. Goddard, American pioneer in rocket research
- Goddard is the lead Center in NASA's earth science program.
- Manages and operates the Hubble Space Telescope
- Operates the Tracking and Data Relay Satellite System (TDRSS)
- <http://www.gsfc.nasa.gov>

Jet Propulsion Laboratory (JPL)
Pasadena, CA 91109-8099

- Established in 1936
- A research, development, and flight center operated for NASA by the California Institute of Technology.
- Primary role is the investigation of the solar system through the use of robotic scientific spacecraft.
- <http://www.jpl.nasa.gov>

Johnson Space Center (JSC)
Houston, TX 77058-3696

- Established in 1961 as the Manned Spacecraft Center. It later named Lyndon B. Johnson Space Center (JSC) in honor of the late President.
- Training base and home for our nation's astronauts and the site of Mission Control Center for U.S. human space flights.
- <http://www.jsc.nasa.gov>

Kennedy Space Center (KSC)
Kennedy Space Center, FL 32899-0001

- Established in 1961
- The nation's spaceport, the liftoff site for all manned missions into space.
- Center of excellence for launch and payload processing systems as well as the lead center for acquisition and management of expendable launch vehicle services and payload carriers.
- <http://www.ksc.nasa.gov>

John H. Glenn Research (GRC)
Center at Lewis Field
Cleveland, OH

- Established in 1941
- NASA's lead for research, technology, and development in aircraft propulsion, space propulsion, space power, and satellite communication.
- <http://www.grc.nasa.gov>

Marshall Space Flight Center (MSFC)
Huntsville, Alabama 35812-0001

- Established in 1960
- NASA's Lead Center for Microgravity Research,
- World leader in space propulsion and transportation systems.
- As NASA's Lead Center for Space Transportation Systems Development and its Center of Excellence for Space Propulsion, Marshall bears the responsibility of unlocking the door to exploration and development of space.
- <http://www.msfc.nasa.gov>

Stennis Space Center (SSC)
Stennis Space Center, MS 39529-6000

- In 1961, a historic announcement was made: the federal government had selected an area in Hancock County, Miss., to be the site of a static test facility for launch vehicles to be used in the Apollo manned lunar landing program
- Center of Excellence for Rocket Propulsion Testing
- NASA's lead for enabling companies to Commercialize Remote Sensing. A contributor to NASA's Mission to Planet Earth in Coastal Scientific Research
- <http://www.ssc.nasa.gov>

Wallops Flight Facility (WFF)
Wallops Island, VA 23337-5099

- Established in 1945 by the National Committee for Aeronautics, as a center for aeronautic research.
- NASA's principal facility for management and implementation of suborbital research programs.
- A division of Goddard Space Flight Center
- <http://www.wff.nasa.gov>

White Sands Test Facility (WSTF)
Las Curces, New Mexico 88004-0020

- Built in 1964 to support ground testing of the spacecraft propulsion systems for the Apollo program
- Occupies a 94-square-mile corner of the U.S. Army's White Sands Missile Range and is a tenant of that range under an agreement between NASA and the U.S. Army.
- A division of Johnson space Center
- <http://www.wstf.nasa.gov>

Langley Research Center (LRC)
Hampton, VA 23681-0001

- Established in 1917 as the first national civil aeronautical laboratory
- Lead Center for management of the Agency's technology development programs for future High-Speed Civil Transport, for hypersonic vehicle concepts, and for general aviation.
- <http://www.larc.nasa.gov>

Goddard Institute Space Studies (GISS)
New York, New York 10025

- Established in 1961 by Dr. Robert Jastrow to do basic research in space and Earth sciences in support of Goddard programs.
- Key objective of GISS research is prediction of atmospheric and climate changes in the 21st century. A division of Goddard Space Flight Center
- <http://www.giss.nasa.gov>

Independent Verification and Validation (IV&V) Facility Fairmont, West Virginia 26554
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- Established in 1993
- Provides independent software verification and validation for NASA programs and projects.
- Manages a research program to develop methodologies, tools and techniques to improve the quality of IV&V
- Technically independent organization
- Founded under the NASA Office of Safety and Mission Assurance
- A division of Goddard Space Flight Center
- <http://www.ivv.nasa.gov>

3.2 IV&V Facility

The NASA Independent Verification and Validation (IV&V) Facility was established in 1993 as part of an agency-wide strategy to provide the highest achievable levels of safety and cost-effectiveness for mission critical software and systems. The IV&V Facility was founded under the NASA Office of Safety and Mission Assurance (OSMA)¹, as a direct result of recommendations made by the National Research Council (NRC) and the Report of the Presidential Commission on the Space Shuttle Challenger Accident.

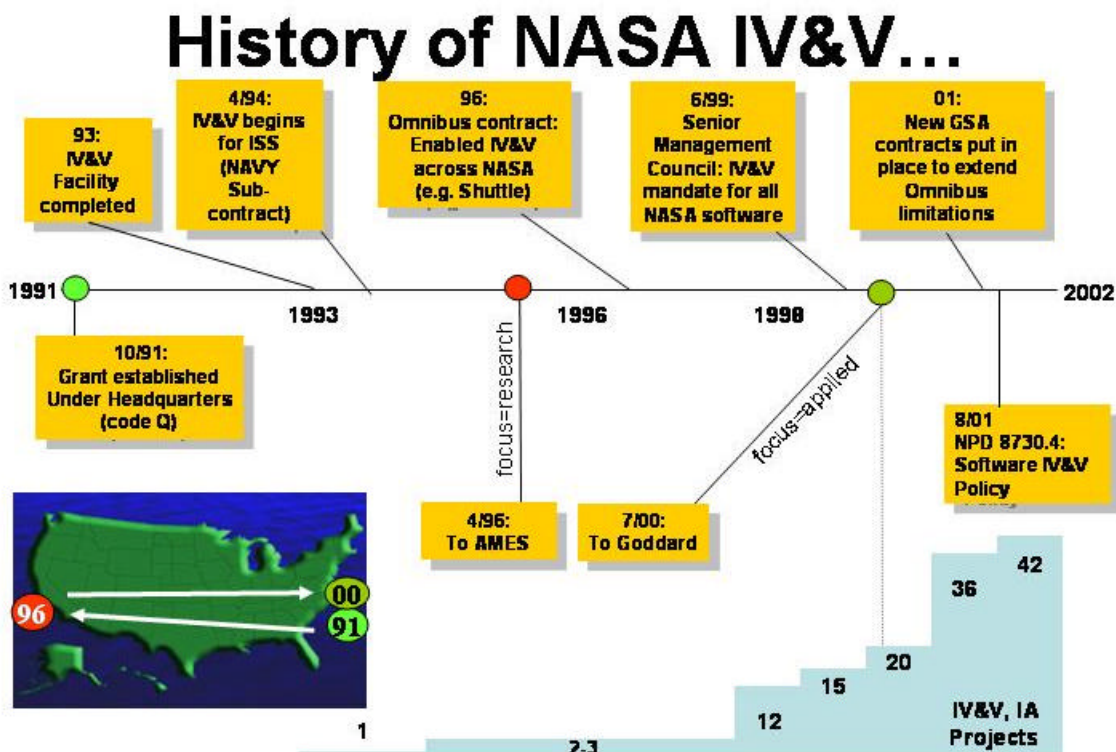


Figure 1 NASA IV&V History

Today, the IV&V Facility is governed by the NASA Headquarters. The IV&V Facility is managed by the GSFC. Figure 2 portrays this association.

¹ OSMA/Code Q - <http://www.hq.nasa.gov/office/codeq>

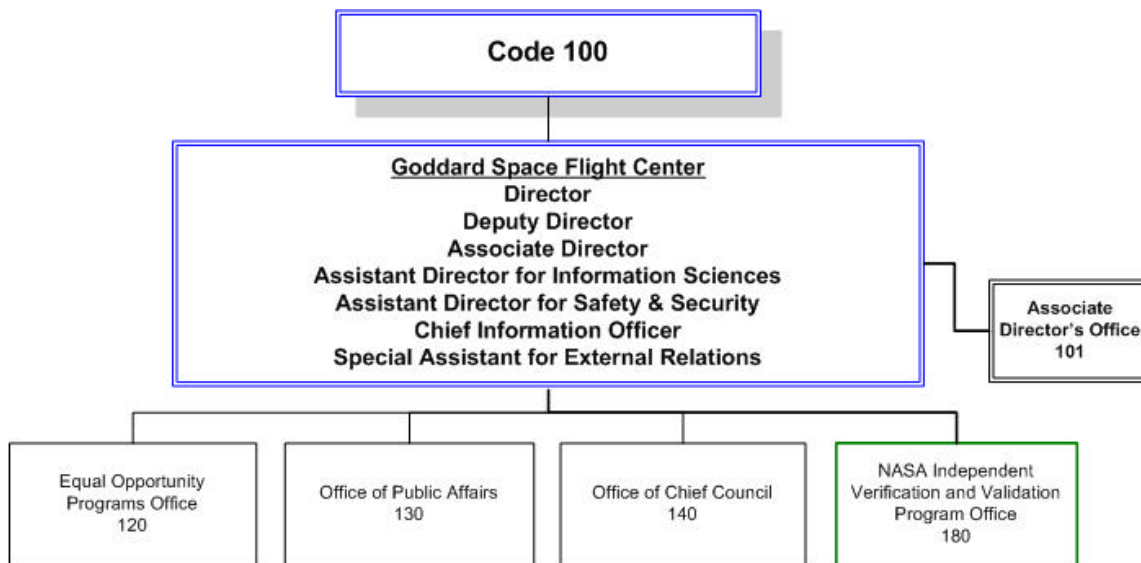


Figure 2 GSFC/IV&V Organization²

The IV&V Facility is the NASA lead organization for software IV&V, and is responsible for the management of all software IV&V efforts within the agency. The IV&V Facility's role is to provide value-added service to the agency's software projects, primarily by performing IV&V on software, when appropriate, based on the cost, size, complexity, life span, risk, and consequences of failure (per NPD 8730.x)³. The IV&V Facility is also responsible for independent evaluations of mission critical software development processes and products for NASA projects.

The IV&V Facility works to advance the science of software engineering to improve the safety, quality, reliability, cost, and performance of NASA software systems. To achieve its mission, the IV&V Facility manages a research program to develop methodologies, tools and techniques to improve the quality of IV&V of the software produced by and for NASA.

What are the Benefits of IV&V?

- ❖ Increases safety
- ❖ Provides increased visibility for programs into the software development process
- ❖ Identifies non-essential requirements
- ❖ Determines compliance between specification and performance
- ❖ Identifies risks associated with software
- ❖ Permits fewer latent defects
- ❖ Reduces development and maintenance costs

3.2.1 Mission and Vision

The IV&V Facility's vision and mission are defined as follows:

² as of June 2, 2003

³ NPD in effect: 8730.4; effective date: August 01, 2001

Vision – To be recognized as the preeminent organization applying and improving independent verification and validation for software and systems.

Mission – To ensure that our customer's mission-critical software and systems are of the highest quality and are reliable and safe by applying software and systems expertise and tools, while researching new approaches, deploying innovative solutions, providing a learning environment , and participating in the vitality of the community.

To fulfill its mission and reach its vision, the IV&V Facility has adopted a strategic plan⁴ and currently working toward to achieve the overreaching goals.

3.2.2 Customers

The IV&V Facility supports programs, projects, and activities managed and implemented by NASA Headquarters and the NASA Centers, including the Jet Propulsion Laboratory (JPL). The IV&V Facility and personnel support all six of NASA's Enterprises. In addition, we support academic researchers and educational outreach programs under the Agency's directive.

The NASA IV&V organization has implemented a customer focus plan to better serve their valuable customers by putting them first and foremost in all IV&V do. Please review the IV&V Facility's strategic plan for details.

3.2.3 Quality Management System

The IV&V Facility has implemented a quality management system in order to assure that their customers are receiving service of highest quality. As part of this process the IV&V Facility has adopted ISO 9001:2000 as a management systems model.

The Quality Manual defines the system and processes, which is located at the IV&V Facility IMS site.⁵ The following System Level Procedures (SLP) will present the IV&V Facility's new PM personnel with an illustration of the procedures/requirements that are generally applicable to the PM's duties. A complete list can be found at the Facility's IMS site.

Document #	Title
IVV QM	Independent Verification & Validation Facility Quality Manual
IVV 09-4	Project Management
IVV 09-1	Independent Verification & Validation
IVV 09-2	Independent Assessments
IVV 09-8	Project Start-up
IVV 03	Contract Review

⁴ see *Mapping a Successful Future*, the Facility's Strategic Plan 2003-2008

⁵ <http://ims.ivv.nasa.gov>

Table 1 System Level Procedures

3.2.4 Organization Chart and Selected Position Descriptions

The following is the IV&V Facility management organizational chart.

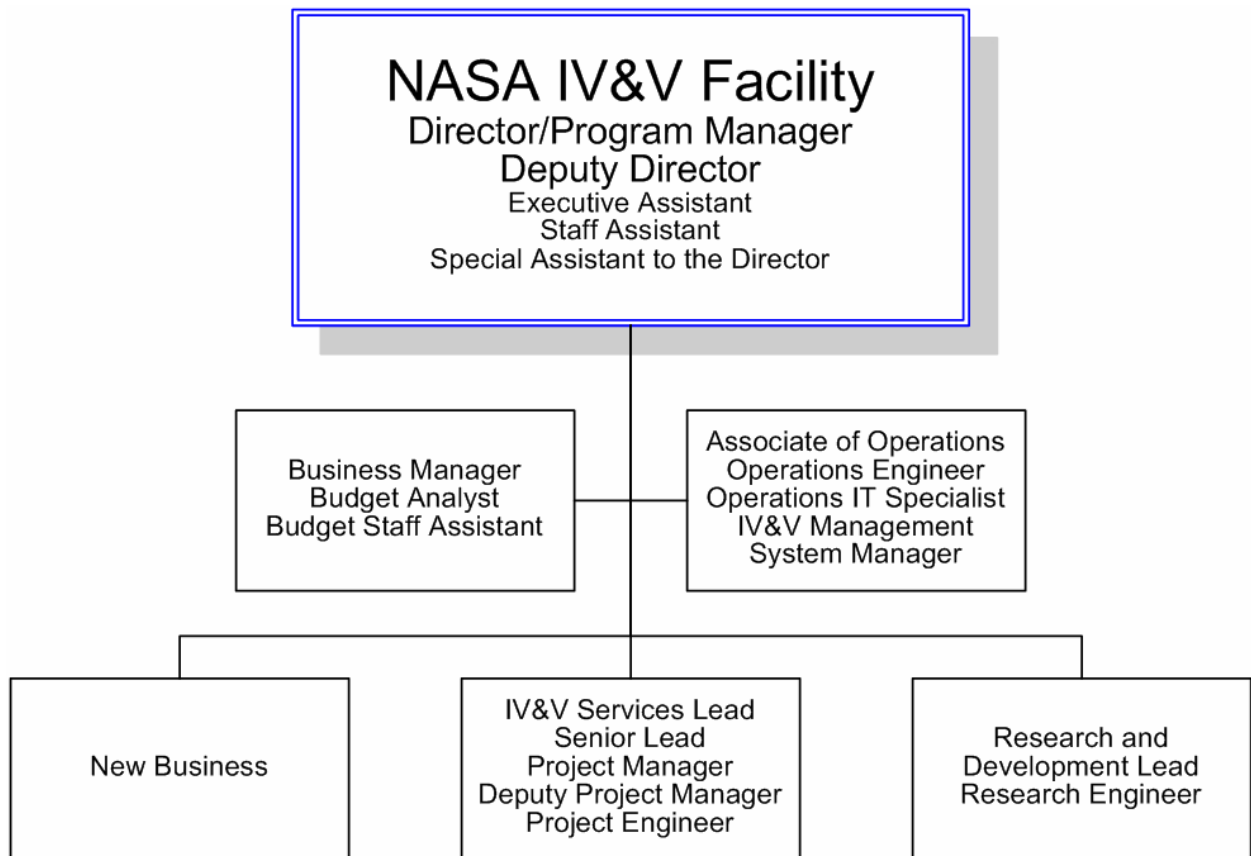


Figure 3 IV&V Facility Organization chart

- **Project Manger**

The Project Manager (PM) is responsible to the IV&V Facility for the successful planning and execution of the IA/IV&V for all assigned missions. The PM functions as the formal point of contact between the Project and the IV&V Facility. All formal issues and deliverables should go through the PM. The PM is responsible for all aspects of a given mission, including: resource management, schedule, IV&V activities, deliverables and customer interface. The procedure defining the project management responsibilities for the IV&V Facility is listed in *SLP IVV 09-4*.

- **COTR**

The Contracting Officer Technical Representative (COTR) is responsible for the designated contract's continuation of services. COTR works with PMs and Business Manager on funding issues. He/She is responsible for items on the COTR delegation form. The procedure defining the COTR responsibilities for the IV&V Facility is listed in *SLP IVV 08*.

- **Senior Leads**

The Senior Leads are generally distributed across NASA Enterprises/Centers. The role of the Senior Lead is to act as the IV&V Facility's Primary Point of Contact with their assigned Enterprise/Center. In this role, Senior Lead manages the implementation of existing Enterprise/Center projects with direct responsibility for day to day efforts delegated to the IV&V Project Manager. The Senior Lead is responsible for working with the PMs assigned to the projects within the Lead's scope and to help in resolve issues related to IV&V and the management of the projects. The Senior Lead will backup PM's on individual missions (as necessary).

- **IV&V Services Lead**

The IV&V Services Lead works closely with the Senior Leads to ensure the Facility's IV&V mission is being accomplished in an accurate and efficient manner. The Services Lead will formalize and encourage the use of best practices throughout the IV&V Services Organization. The Services Lead will assist the New Business Lead in establishing and cultivating new business opportunities and will assist the Research Lead in developing tools and processes to advance the practice of IV&V. The Services Lead will backup the Senior Lead and PM on individual missions (as necessary).

- **New Business Lead**

The New Business Lead is responsible for monitoring the establishment of new Agency missions and assessing the high level IV&V needs for those missions. The New Business Lead will ensure that the appropriate Projects complete a self assessment and then provide a rough order of magnitude IA/IV&V cost for missions to use in their budget formulation. The New Business Lead will work with the Senior Leads and the IV&V Services Lead to keep them informed of upcoming projects and plans the transition efforts from New Business to IV&V Services. The New Business Lead will assist the Research Lead in developing tool/processes to advance the practice of IV&V cost modeling, ROI, and IV&V startup and determination activities.

- **Research Lead**

The Research Lead oversees all research managed by the IV&V Facility, including Center Initiatives (CI), IV&V Facility Research Initiatives and West Virginia University Initiatives (UI). The Research Lead defines research goals, objectives and policies. Research Lead conducts monthly Research Coordination Team (RCT) meetings to better align the research program with the IV&V Facility needs and organizes an annual Software Assurance Symposium (SAS). The procedure defining the research and its program management responsibilities for the IV&V Facility is listed in *SLP IVV 09-3*.

4 Project Management Process

4.1 Introduction

The primary objectives of the IV&V activity are to provide the Project with assessments of the software deliverables and processes for the development aspects of the Project. The IV&V activity, although independent of the developer, is an integral part of the overall development of the Project and is planned to mitigate any inherent risks associated with developing safety and mission critical software.

Software IV&V is a critical management control that helps ensure the safety, quality, and reliability of NASA's software. Software verification consists of assessing objective evidence at different phases of the development life cycle to ensure that the software product complies with specifications. Software validation takes place at the end of the software development process and consists of performing tests and assessing other objective evidence to determine whether a software system will accomplish its intended purpose. Validation ensures that a software system will perform as expected under operational conditions.

Software IV&V is a systems engineering process employing rigorous methodologies for evaluating the correctness and quality of the software product throughout the software life cycle.

Independence is a key component to successful software verification and validation. Software developers and project managers may have vested interests and may not be objective in their self-assessments. Performing software verification and validation independently of the development and management functions helps to ensure that verification and validation activities are unbiased and based on objective evidence.

NASA policy requires all Programs and Projects directed by **NPG 7120** to determine the level of IV&V to be performed with the explicit involvement of the NASA IV&V Facility. The IV&V Facility PM is responsible for the planning and successful execution of IV&V or IA for the assigned missions.

4.2 Project Implementation

Once the IV&V Facility becomes aware of new projects or missions, the New Business Lead in cooperation with the appropriate Center Lead arrange for the Project to perform a self assessment to identify the level of support. The Project Startup process is outlined in the *SLP IVV 09-8*. For projects requiring IA or IV&V, the IV&V Facility Deputy Director assign a IV&V Facility PM to manage the IA/IV&V activities. The IA is performed as defined in the *SLP IVV 09-02*. The procedure for the IV&V is listed in the *SLP IVV 09-01* and the *SLP IVV 09-4* defines the project management responsibilities.

- Negotiation period

The PM, with assistance from the Senior Lead and the New Business Lead coordinate with the Project to identify the initial scope of the task. The PM should negotiate an

agreement with the Project on the technical, managerial and business characteristics of the tasks.

- Establish Customer Agreement

Once the PM and the Project has concurred on the scope of the work to be performed, a customer agreement must be established between the IV&V Facility and the Project. The PM will negotiate a formal agreement with the designated POC representing the Project.

- Memorandum of Agreement

The type of agreement with the IV&V Facility and the Project will typically be a Memorandum of Agreement (MOA). The MOA will be reviewed and signed by the IV&V Facility and the Project. Figure 4 shows the MOA review process.

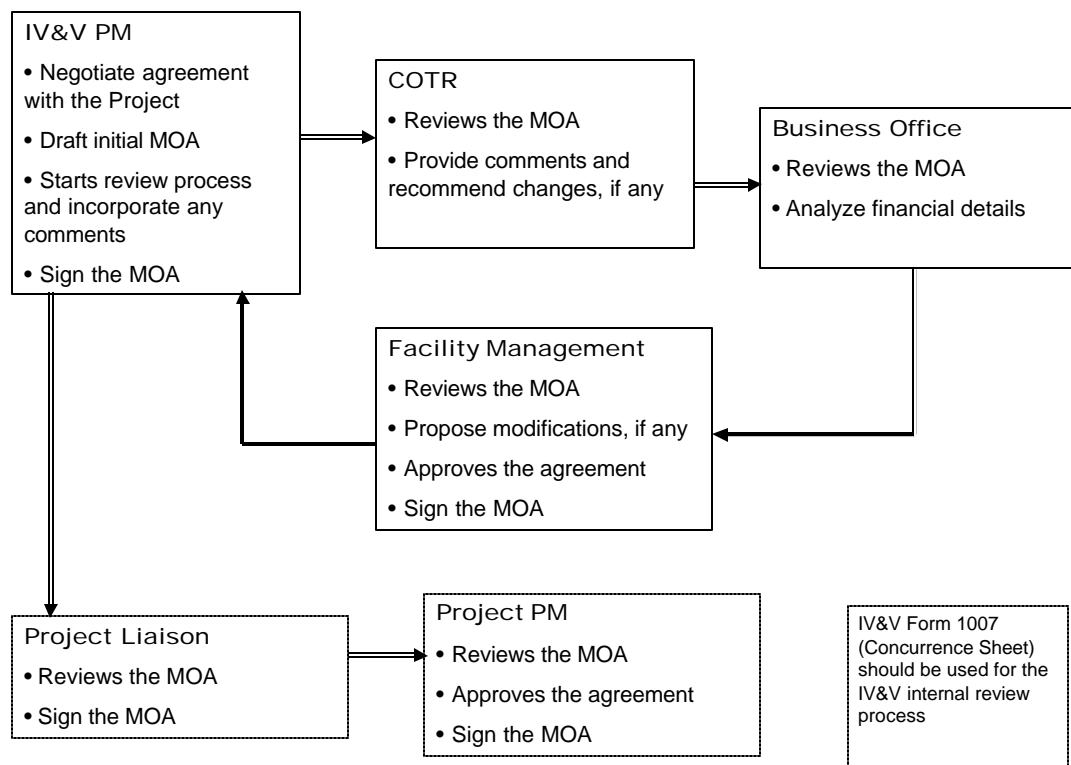


Figure 4 MOA Review and Signature process

The MOA will contain but is not limited to the following sections:

- Purpose
- Duration
- Schedule and Milestones
- Points of Contact
- Roles and Responsibilities

- Tasks to be performed
- Deliverables, if any
- Budget
- Resources
- Signatures

- Identify Team

The PM works closely with the IV&V Facility management, COTR, financial personnel and contractors to identify team members necessary to perform the determined IV&V tasks. The PM coordinates with the contractor and associated COTR to put the required task order in place to initiate the effort. The PM, with support from the Team, will discuss with the Project to identify the specific tasks to be performed and any special resources required to accomplish the work.

- Project Plan

A Project Plan should be developed and provided to the Project. The Plan outlines the activities to be performed, reporting requirements associated with the Project, communication process, etc. The Project Plan should be updated if the scope or any key changes are warranted.

4.2.1 Establish the Appropriate Level of IV&V

To identify the appropriate level of IV&V, the IV&V Facility uses a Facility standard process. This process will define the level of IV&V performed per software functions, as it is not necessary or financially feasible to perform a full suite of IV&V. The Project schedule and budget constraints are also considered in the planning process to tailor the IV&V program.

4.2.2 Project Life Cycle

The initial IV&V Project life cycle phases follow a waterfall approach as seen in SLP IVV 09-8, *Project Startup*. The rest of the IV&V Project life cycle proceeds as defined in IVV 09-4, *Project Management*.

For more information on the IV&V Analysis tasks and the WBS, please see SLP IVV 09-1, *Independent Verification and Validation*.

4.2.3 Products Evaluation

All project specific deliverables should be evaluated by the PM for quality. The PM is responsible for ensuring that all products delivered to a Project are in an appropriate format. Additional information, including the “Email Instructions” for the PM, can be found in the SLP IVV 09-4.

4.2.4 Concurrence

For formal agreements, the concurrence participant list is defined in IVV 09-4.

For project deliverables, the concurrence participant list consists of the IV&V Project Manager as the originator and approver.

In the case where a reviewer or approver requests changes to the item under review, then the reviewer or approver should note the request in the comments section of the concurrence form and return the concurrence package to the originator without signing for concurrence. The originator should make the requested changes, mark as a working document and retain the original item as part of the concurrence package until the concurrence process is complete, note that the changes have been made in the comments section of the concurrence form, and initial and date below the originator block of the concurrence form. The originator will start the package through the process again. Each reviewer will initial and date their concurrence below their name on the concurrence form if already signed.

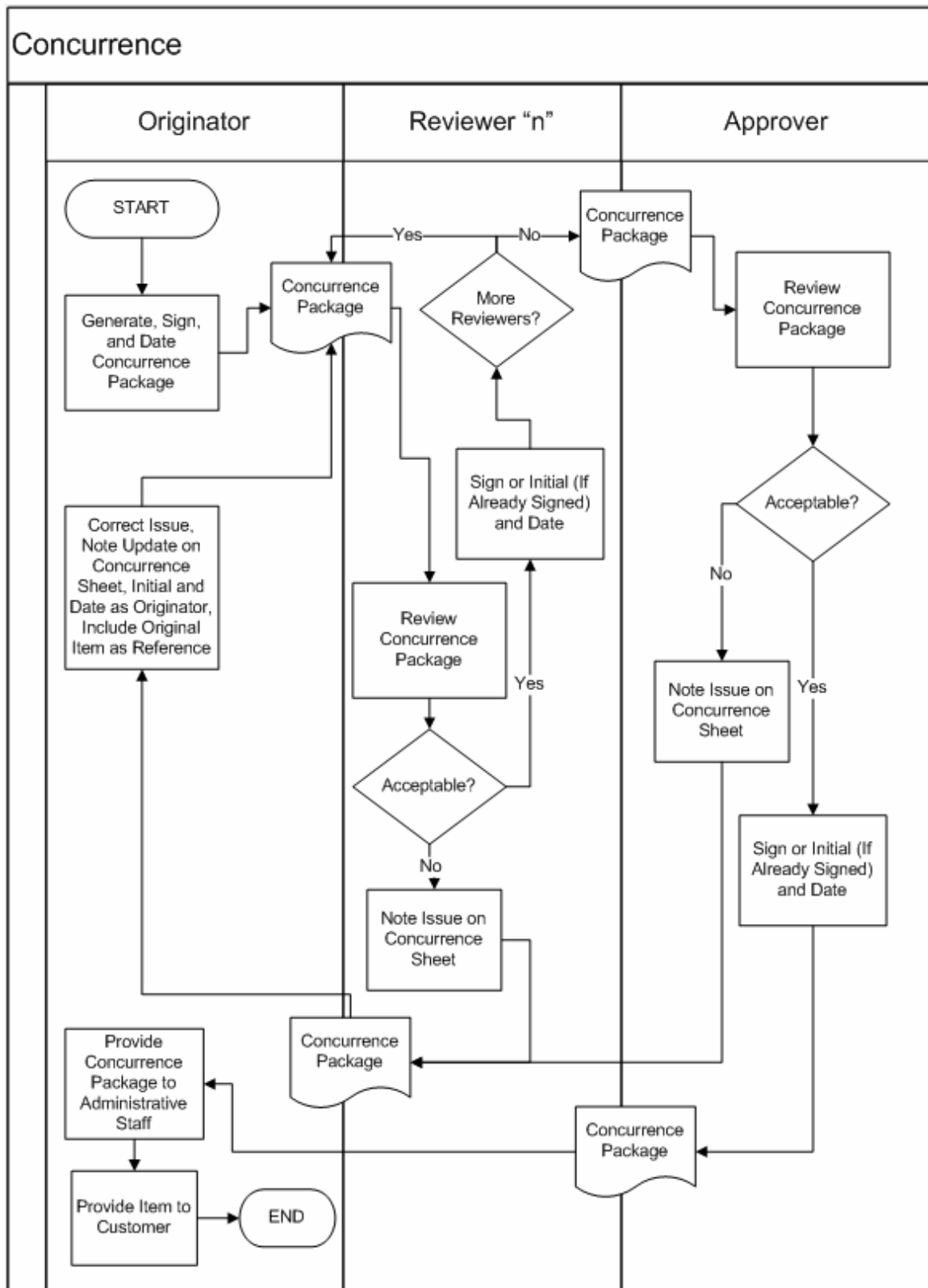


Figure 5 - Concurrence Process

4.2.5 Communication Process

To provide better service and meet the needs of the projects, the PM should maintain regular contact with the Projects. It can be accomplished either via telephone, email or face-to-face meetings.

The figure xx below is a graphical representation of the common interfaces between a project and the IV&V effort for that project. Note that the representation does not show all interfaces between the IV&V Facility and the project.

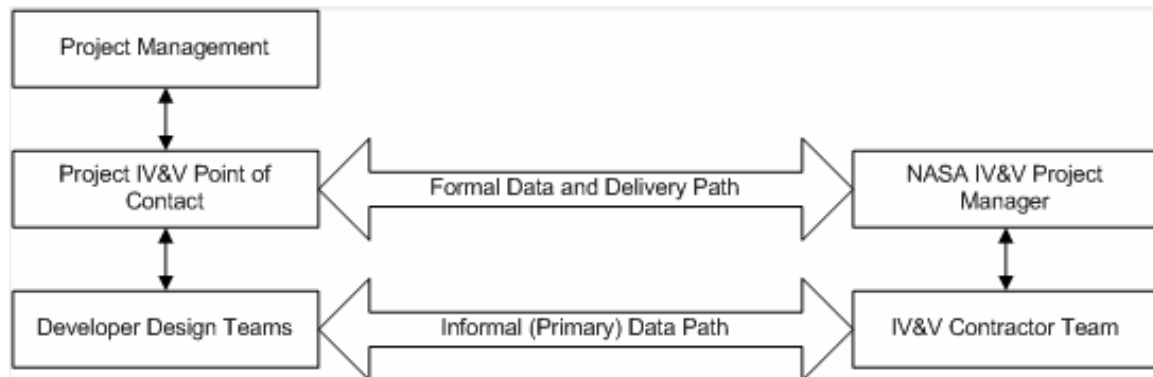


Figure 6 – Interface between the Project & the IV&V Team

4.3 PM Tool

The Project Management Tool (PMT) is an in-house tool designed to support the PMs with the management of the IV&V Facility projects. All PMs are expected to fully utilize this tool in managing their assigned missions. For details on using PM Tool to input or generate reports, such as MSR or GMR reports, refer to the PM Tool Help.

4.4 Project Financial Management

The PM is responsible for the financial management of the Project, including preparing the Project's financial spending plan, tracking, verifying the financial data from the contractor (533s) and formulating out year financial projections. The following sections briefly describe the Project's financial management.

4.4.1 IV&V Facility Costs

In the G&A funding scheme, typical dollars allocated to projects do not need a Facility "tax" assessed. However there are exceptions to this rule. The Facility currently charges two types of tax. The first is a Reserve Tax. This is very similar to the O&M and DDF taxes of the past. Funds sent to IV&V to perform additional work on any given project are subject to this tax. Reserve Tax = 10% of total funding received for a task. The Reserve funds are to be used at the Director's discretion. The second is a Pass-Through Tax. Funds that are sent to the Facility for use of raised floor space, use of contract vehicles, etc. are subject to this

tax. Pass-Through Tax = 6% of all funds received for usage. The Pass-Through funds are to be used at the Director's discretion. These taxes may be waived in full or in part by the director if deemed necessary.

4.4.2 533 Analysis

Contractors are required to submit form 533Q at the start of a task order and each quarter thereafter to project future expenses and show a history of actual expenses. Contractors are required to submit a form 533M each month to report actual expenses for the reporting month as well as next month's projections. The NASA IV&V PM must review the 533Q and 533M forms for their assigned missions to ensure correctness. The 533M planned and actual columns for a given month should have nearly the same values.

4.4.3 Monthly 533 Review Guidelines

All PMs should review the monthly 533s within ten working days of receipt in the following manner:

- Review Actual Monthly and Cumulative hours and labor cost to the planned information.
- Review the Travel-Relocation, ODC, G&A, Subcontractor ODC, Material and Material Handling amounts for reasonability.
- Is there unusual variability in the above amounts? If so, what is the explanation for the variability?
- Does the actual information seem comparable to the work performed?
- Is the Actual Cost FY CTD (533M) on track with Plan Cost FY CTD (533Q)?
- When the Earned Value data comes in compare it with the 533M data for consistency.
- Is your Planned Carryover on track? If not, understand it and document why not?
- Do you need to submit a Baseline Change Notice for your project?

The COTR should review the same information as above to ensure that it is on track at the contract level:

- Is there enough money PR'ed to cover future work?
- Do you need to exercise an Option Year for your contract?

- Do you have enough ceiling on the contract to accommodate anticipated work throughout the remainder of the Option Year?

4.4.4 Budget Reviews

At the end of every month, a financial review will be held by the Business Office to analyze the projects and contracts funding plans, costs and commitments. Unless otherwise specified, a PM is obligated to be present at the review meeting. In addition, the PM is required to review his/her appropriate project financial spreadsheets and initial the budget review checklist prior to the meeting.

4.5 Risk Management

Risk management is an integral component of Project Management; as such PMs are expected to perform risk management on their projects. Risk management involves the identification of risk(s), analysis of risk(s), planning for risk(s), monitoring, controlling and tracking of risks, and communicating and reporting of risks.

4.5.1 Risk Categories

Risks that are routinely encountered on IV&V Projects can be categorized into IV&V related risks and Development Project related risks.

IV&V related **risks** are those that are related **to the performance of IV&V** (unable to perform IV&V to the technical level necessary within the schedule and allocated funds (e.g. Project is issuing immature artifacts which is requiring significantly more effort to analyze)) or **risks to the Facility** (risks that may impact the Facility as a whole (e.g. potential project cancellations, low quality product delivered to our customer, etc)).

Development Project related **risks** are those that are related **to the development Project** that IV&V has identified as a result of our tasks and have communicated to the Project (e.g. inadequate test program resulting in a risk of unidentified errors during operation).

4.5.2 Risk Sources

There exist many sources of risk for both IV&V related risks and development Project related risks. The intent of this subsection is to identify some of the common sources of risks that have been encountered.

Sources of IV&V related risks typically include but are not limited to: staffing/changes in staffing, project artifact availability, contract limitations/constraints, available funding/funding levels, tool availability, cycle time for agreements, feedback from development Projects, etc, development project related changes (changes in scope, design/architecture changes, schedule slips/changes, etc), development Project's openness to IV&V, etc.

Sources of development Project related risks typically include but are not limited to: lack of adherence to standards/requirements, inadequate software development work products, development environment, technology, software development process maturity, engineering specialties (maintainability, reliability, safety, human factors, etc).

4.6 Mission Tracking Sheet

The Mission Tracking Sheet identifies the IV&V Mission Milestones. This spreadsheet is setup to track the progress in establishing new IV&V and IA projects and identifying trends. The PM is responsible to keep the mission tracking sheet updated for their assigned mission. This matrix is located on the *NASA shared drive*.

4.7 Earned Value Analysis

Contractors are required to submit Earned Value (EV) Management data monthly. The EV data is reconcilable to the 533 data from the previous section. The actual cost of work performed (ACWP) should match the actual costs given on the 533M for the month. Any deviations of more than **10%** of the ACWP from the budgeted cost of work scheduled (BCWS) or the budgeted cost of work performed (BCWP) must have an explanation given by the contractor. The BCWS is the baseline schedule of what is planned to occur on the project. The BCWP reflects the actual state of the project with respect to the original budget.

For example, if the BCWS states that milestone A will be reached in month 1 at a cost of \$1,000 milestone B will be reached in month 2 at a cost of \$500, and milestone C will be reached in month 3 at a cost of \$500 and at the end of month 2 milestone A has been achieved but milestone B has not, then the BCWP as of month 2 is \$1,000. Thus there is a schedule variance (SV) of

$$SV = BCWP - BCWS = \$1,000 - \$1,500 = -\$500$$

Since we expected milestone A and B (\$1,000 + \$500 = \$1,500) to be completed, the SV% is

$$SV\% = 100\% \times SV / BCWS = 100\% \times -\$500 / \$1,500 = -33\%$$

This large variance must be justified by the contractor in writing. Suppose the cumulative actual cost reported on the 533M was \$1,250. The cost variance (CV) compares the BCWP to the ACWP using

$$CV = BCWP - ACWP = \$1,000 - \$1,250 = -\$250$$

The CV% is then

$$CV\% = 100\% \times CV / BCWP = 100\% \times -\$250 / \$1,500 = -17\%$$

The cost difference is also in excess of the **10%** allowable variance and must be justified by the contractor.

Some areas of possible concern in earned value include:

- zero variances, especially for cost variance
- continued negative variances
- opposing trends in cost and schedule variance
- change in BCWP with no corresponding change in ACWP

Not all projects require EV data reporting. EVM requirement will be based on several factors, such as project size, duration, etc.

4.8 Project Management Review (PMR)

The assigned PM should prepare a report to present to the IV&V Facility management. The PMR will take place regularly at the weekly staff meeting. Review should consist of the Project overview (i.e. Project start and end dates, Scope, etc.), financial status, risks, contributions and issues. Also included is the Project's Earned Value Management (EVM) data, if the Project has EV reporting. Please see the updated PMR reporting template on the *NASA shared drive* for more information.

4.8.1 PMR Risk Guidance

There are two classes of risks that are to be included in PMR, and each is to be presented differently - risks to our performance of IV&V and risks to the Facility (see section Risk Management above).

- Risks to our performance of IV&V: These are to be presented in the "Risks" section of the PMR.
- Risks to the Development Project: These are presented in the "Significant Accomplishments" section of the PMR as appropriate.

4.9 Peer Review Requirements

All formal presentations given to a Project/Customer by a PM is required to go through a peer review process in advance. This review will be conducted in a meeting setting with the applicable Senior Lead(s), the Services Lead as described in the following table.

Type of Briefing	Required Peer Reviewers
Formal Presentations to Project	Project Senior Lead, Services Lead
Project Scope Change (technical or financial)	Project Senior Lead, Services Lead
Startup Assessment Results	All Senior Leads, Services Lead

5 IV&V Facility Research Activities

5.1 Overview

The IV&V Facility Research Program aims to foster advances in the field of software engineering to improve the safety, quality, reliability, cost, and performance of NASA software systems. Events have shown that software reliability is as critical to mission success as hardware reliability. In contrast to hardware, the methods needed for developing, testing and certifying mission critical software are not fully developed. New techniques and methodologies for all phases and aspects of software development are continually being introduced and existing techniques and methodologies are constantly being refined.

The NASA IV&V Facility is charged with remaining ahead of the developers applying these new approaches by creating IV&V tools and techniques that are applicable to the new development techniques and advanced computing architectures. To assist NASA in becoming a leader in the development of safe, reliable, cost-effective software, the IV&V Research Program is intended to develop the tools and methodologies needed to improve the quality of the software produced by and for NASA as well as improving the techniques needed to perform effective IV&V on NASA Projects.

5.2 Funding

Below is a diagram illustrating the flow of money to research initiatives:

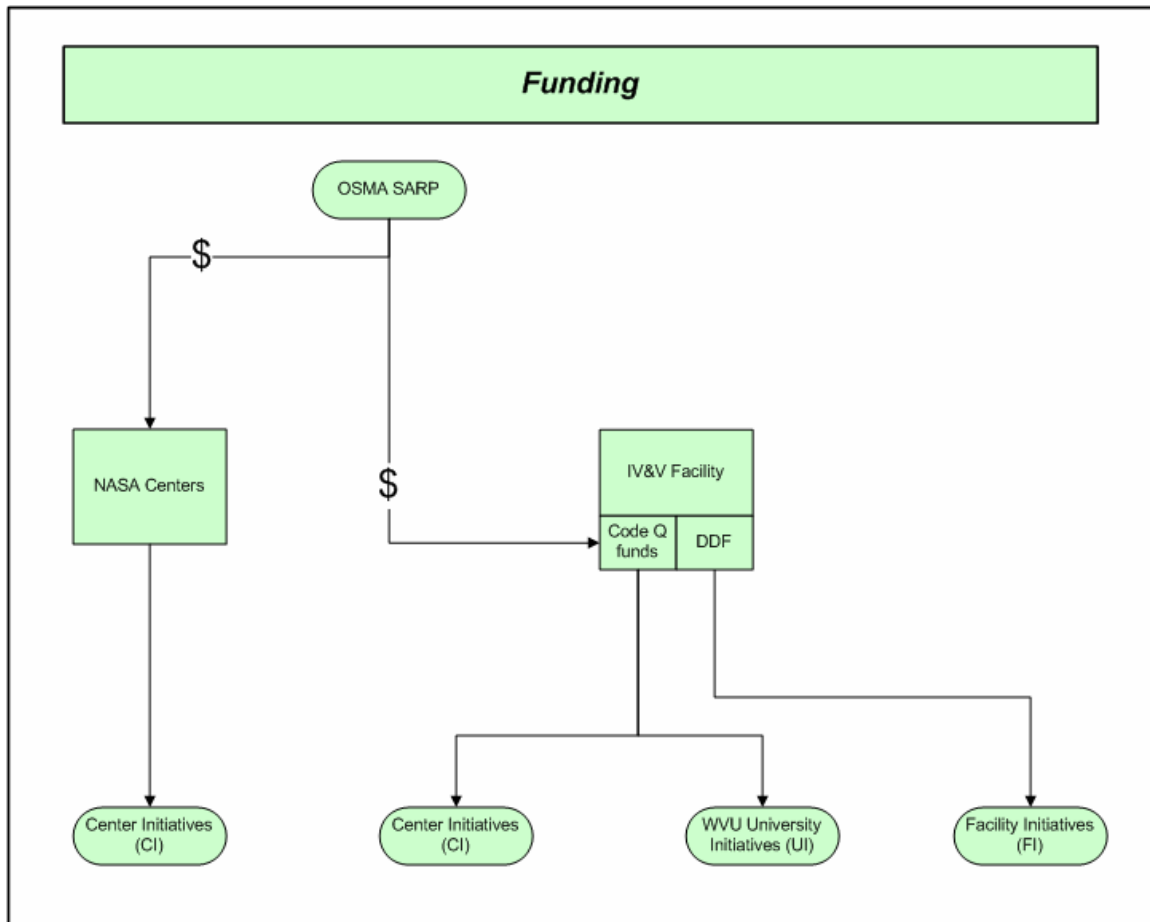


Figure 7 Research Initiative Funding

5.3 Research Initiatives

The NASA IV&V Facility manages three types of research initiatives; Center Initiatives (CIs), Facility Initiatives (FIs), and University Initiatives (UIs). Each research initiative is actively managed by a government Point of Contact (POC), usually a PM. All POCs are government civil servants or JPL employees. Government POCs are located at Centers, JPL, or at the IV&V Facility. The Government POCs for the initiatives are typically stationed at the Facility or Center that is contractually sponsoring their initiative. For example, if Goddard has a research initiative on Code Inspection, the Government POC for that initiative would be located at Goddard.

Initiatives can be performed by civil servants, JPL employees, or contractors. If the initiative is performed by a contractor, the Government POC is usually the Contracting Officer Technical Representative for that initiative. Center Initiatives are conducted by Principle

Investigators (PIs) that are located at Universities, NASA Centers, Organizations, and other Government agencies across the country.

All of the Center Initiatives are funded through the Code Q Office of Safety and Mission Assurance (OSMA) Software Assurance Research Program (SARP). The OSMA SARP is managed on a day-to-day basis by the NASA IV&V Facility and is designed to address fundamental problems in the field of software assurance, primarily as it related to software safety, quality, testability, reliability, and IV&V. The POCs for the CIs can be located at the IV&V Facility as well as any of the NASA Centers.

The NASA IV&V Facility Initiatives (FI) are funded by the IV&V Director's Discretionary Fund (DDF) and directly focus on research that is of specific interest to the IV&V Facility. Facility Initiative awards are based on the availability of DDF funds and the applicability of the research to IV&V. Given the source of funding and nature of the research, the FIs are always managed by a POC located at the IV&V Facility.

University Initiatives are similar to CIs in that they are funded through the OSMA SARP and they addresses fundamental issues in the field of software assurance, however they are limited to PIs from West Virginia University (WVU). The NASA IV&V Research Chair oversees the UIs, and the NASA IV&V Research Lead is the government POC for the UIs.

5.4 Initiative Selection and Management Process

The IV&V Facility determines OSMA SARP research needs by observing areas of current and past research and through querying NASA projects, NASA Headquarters personnel, and Software Working Group (SWG) personnel. The IV&V Facility determines IV&V Facility research topics by observing project needs and through querying the Research Coordination Team (RCT). The IV&V Facility documents the research topics and posts them on the IV&V web site each year in preparation for the annual proposal solicitation.

During the first quarter of the calendar year the IV&V Research Team initiates the process to select and manage new OSMA SARP initiatives for the upcoming fiscal year. The IV&V Facility begins the process by drafting the OSMA SARP Level I Plan which it passes to Associate Administrator of Code Q for approval. The Level I Plan serves as the basis for the internal NASA Program Operating Plan (POP) call for research proposals and it also describes the plan for issuing the OSMA SARP's annual NASA Research Announcement (NRA). The NRA is essentially a request for proposals (RFP) which originates at the IV&V Facility and serves as the instrument for requesting research proposals directly from industry and academia.

Each year the IV&V Facility Research Team conducts annual evaluations of on-going research initiatives eligible for renewal to provide funding recommendations to Code Q for the following year. The annual evaluation is the culmination of numerous evaluations conducted during the year by the Research Team and the POC at the initiative reviews, deliverable reviews, the Software Assurance Symposium (SAS), and other interactions between the research team and NASA.

At approximately the end of the second calendar quarter the IV&V Facility opens the 2 month solicitation period by posting the NRA in the Commerce Business Daily (CBD) and on the NASA IV&V Facility's Research Program's web-site. The IV&V Facility then accepts proposals, obtains evaluations from the SWG, and provides recommendations regarding award to the Source Evaluation Board (SEB).

The SEB then recommends supplemental funding for each on-going initiative that is eligible for renewal based on the evaluations of on-going research initiatives. The SEB then recommends new awards based on the proposal evaluation results and the remainder of budgeted funds. Code Q selects proposals for award based on the SEB recommendations. The IV&V Facility then drafts the Level II plan which lists all proposals selected for award, as well as defining the funding levels for current initiatives selected for renewal. Once approved with the agency, the researchers are notified of their status regarding the awarded funds. The final release of funds is subject to Fiscal Year Budget approval by Congress.

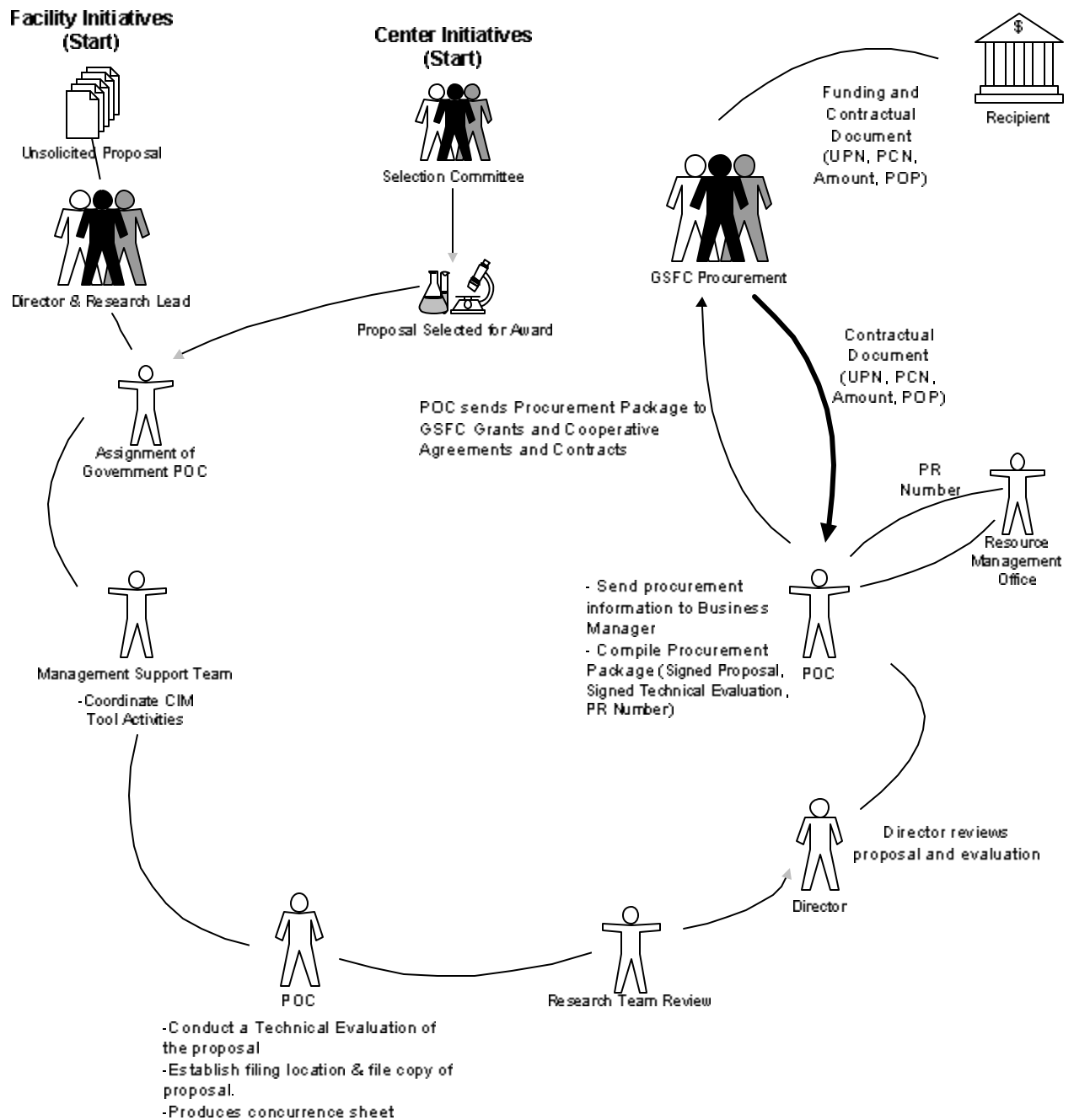
The process for selecting and funding FIs is not as structured as that of the CIs and UIs. As opposed to issuing a RFP, the IV&V Facility accepts unsolicited proposals to conduct IV&V related research throughout the year. All of the FIs are funded independently of the OSMA SARP initiatives through the IV&V Facility's DDF funds. The IV&V Research Lead and the IV&V Facility Director select proposals for award based on availability of DDF funds that offer the most benefit directly to the IV&V Facility.

The process for managing the OSMA SARP funded research initiatives follows a Calendar year cycle, however depending on availability of funds schedule slips may occur. Facility Initiatives, on the other hand, are generally not conducted on a defined cycle. Instead, the funding cycle for the FIs is entirely dependent on the availability of funds.

The government POC for each research initiative is responsible for providing administrative and technical direction for the initiative(s) they are managing. The POC is responsible for ensuring that all efforts defined in the Research Plan are performed in accordance with the approach and in compliance with the standards and procedures as stipulated and also for ensuring that all deliverables and milestones defined in the Research Plan have been received, are in suitable format, and contain valid technical content. In addition, the POC supports initiative reviews between the Research Team and the PI by providing the project's technical and financial status. The POC should also present a report to the IV&V Facility management at the Project Management Review (PMR) on a bimonthly basis.

All OSMA SARP initiatives which were funded in the current year are required to present their findings to date at the annual Software Assurance Symposium (SAS) which typically occurs during the third quarter of the calendar year.

CI and FI Procurement Process



5.5 Resources

CIM Tool – Center Initiative Management Tool is the central repository for all deliverables and serves as the hub of information exchange about OSMA SARP and IV&V Facility initiatives. Deliverables are submitted to the POC for review then posted to the CIM Tool for storage and further review if necessary.

Templates or Forms - These forms are located on the *NASA shared drive* and are also downloadable from the CIM Tool. Documents include Quarterly Review Forms; PMR template for presentation to the IV&V Facility management; and the Deliverable Value form to accompany the PMR template.

Software Research Assurance Program (SARP) Results Website - The SARP Results Website contains OSMA SARP funded research deliverables that will provide significant value to the software assurance community, as well as the software engineering community. The IV&V Facility publishes deliverables on the SARP Results Web Site that resides on the IV&V Facility web site. Prior to publishing results, the IV&V Facility ensures that appropriate public release authorization has been obtained.

5.6 IV&V POC Responsibilities

Once funding is awarded, the POC may want to prepare for the upcoming reporting requirements. The Initiative Review Template and the Project Manager Review (PMR) Template are the two primary reporting vehicles for all research initiatives. The Initiative Review Template is to be downloaded from the CIM Tool by the POC and updated regularly (at least once before each initiative review). The POC is responsible for working closely with the PI to obtain all the information that is required to complete the template.

PMRs are held on a regular basis for the IV&V Facility Director and IV&V Facility Civil Servant personnel in order to inform of recent accomplishments or problems, technical advances or deficiencies, and the financial status of the initiative.

At the beginning of the Period of Performance (POP), deliverable and financial data should be entered in the CIM Tool for the entire period of performance regarding the planned deliverables and milestones. This data is crucial in that it allows the POC, the Research Team, and Facility management to track the technical and financial progress of the research. This information may change or evolve as the initiative progress and should be kept up to date on a quarterly basis with the information contained in the Center Initiative Management (CIM) Tool.

5.7 Data Requests

We are constantly in the process of gathering data needs systematically and reporting these research needs to NASA IV&V managers. This information will change year to year as the structure of the research changes and as more is learned about the data requirements. A goal is to be proactive in this regard and identify the data needs of the researchers so that research can be most effective.

Issues of Export Control and confidentiality associated with the passing of data from projects to researchers exist and are usually addressed in the document of disclosure (or non-disclosure). This document is agreed upon by the stakeholders and typically identifies any restrictions associated with the usage of the data. Such restrictions may include the sanitization of information which allows the tracing back to the original project source. Another condition in the non-disclosure agreement may be associated with who may work with the data (i.e. US national vs. foreign national).

6 IV&V Tools Laboratory

6.1 Overview

The IV&V Tools Laboratory was established during August 2002, and is now housed within the IV&V Facility. The Lab's Vision and Mission focus on satisfying the needs of the IV&V Projects and maintaining its role as preeminent provider of verification and validation Computer Aided Software Engineering (CASE) Tools.

In order to be proactive and meet the needs of the Projects, User Groups have been created that represent the various activities performed on IV&V Projects. While all IV&V Facility employees are encouraged to join, the core members shall be engineers/scientists that actually perform the analysis. The various user groups are:

- IV&V Management User Group (IMUG)
- Requirements Analysis User Group (RAUG)
- Design Analysis User Group (DAUG)
- Code Analysis User Group (CAUG)
- Test Analysis User Group (TAUG)
- Traceability Analysis User Group (TrAUG)
- Interface Analysis User Group (IAUG)

In order to use the IV&V Tools Laboratory, the procedure presented in Figure 9 shall be followed.

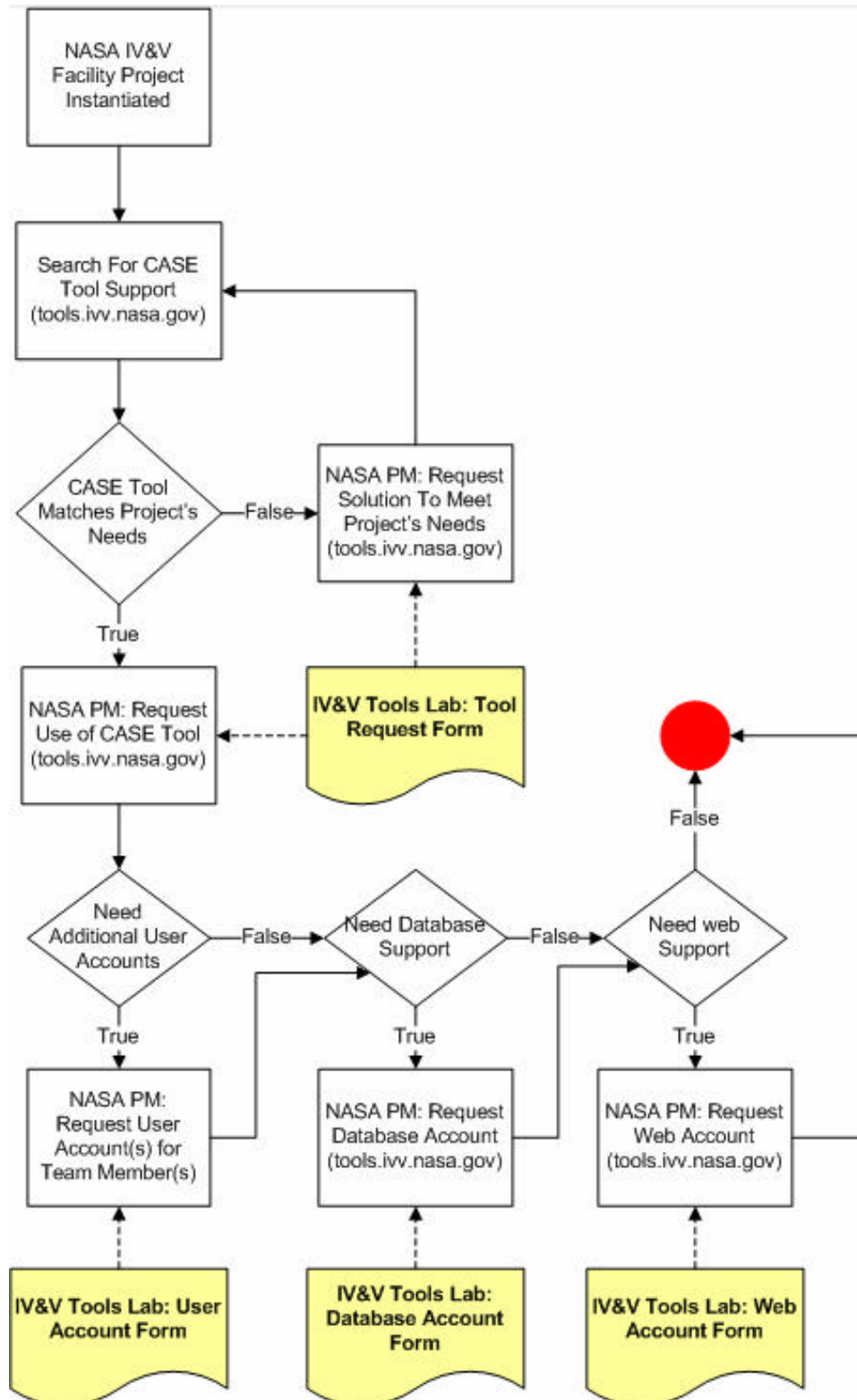


Figure 9 IV&V Tools Laboratory Procedure

Information regarding the tools lab can be found at its home page <http://tools.ivv.nasa.gov>

Appendix A. References

NPD 8730.4 - Software Independent Verification and Validation (IV&V) Policy
NPD 8700.1A - NASA Policy for Safety and Mission Success
NPD 2820.1 - NASA Software Policies
NPG 7120.5B - Program and Project Management Processes and Requirements
IEEE Std 1012-1998 - IEEE Standard for Software Verification and Validation

Appendix B. Definitions

Independent Verification and Validation (IV&V): A process whereby the products and processes of the software development life-cycle phases are reviewed, verified, and validated by an organization that is neither the developer nor the purchaser of the software, which is defined by three parameters – technical independence, managerial independence and financial independence.

Technical independence engages personnel who are not involved in the development activities. IV&V prioritizes its own efforts.

Managerial independence requires responsibility for the IV&V effort to be vested in an organization separate from the organization responsible for development. IV&V maintains independent reporting route to the Program Management.

Financial independence involves funding for the IV&V efforts is allocated by the Program and controlled at high level such that IV&V effectiveness is not compromised.

Verification: It's the process of determining whether or not the products of a given phase of the software development cycle fulfill the requirements established during the previous phase.

Validation: It's the process of evaluating software throughout its development process to ensure compliance with software requirements. This process ensures:

- Expected behavior when subjected to anticipated events.
- No unexpected behavior when subjected to unanticipated events system performs to the customer's expectations under all operational conditions.

Project Plan: A document describing the approach taken for a project, designed for the management of the project. It depicts the work to be done, methods will be used, resources required, schedules, etc.

Overrun: In financial terms, actual costs greater than the approved cost plan in a given fiscal year. This is usually due to unexpected or unplanned reported costs.

Underrun: The actual costs less than the planned costs in a given fiscal year. This could be due to cancellations, savings resulting from tasks being completed early, or purchases being made at less-than-planned costs. Typically, this will be considered as forward funding for the current year or next operating year.

Committed: In financial terms, firm administrative reservation of funds authorizing the creation of an obligation. Commitments only reserve funds; they do not legally bind the government to pay for items or services.

Obligation: Establishes the government's legal responsibility to pay for future goods or services to be received from a contractor, vendor, or grantee. This is accomplished by either letting a new contract or modifying an existing contract. Once an obligation document has been initiated, signed, and processed, the government can begin incurring costs. The act of obligating funds on a contract can be accomplished by a contracting officer.

Appendix C. Training Materials

- IV&V Tutorial - <http://www.ivv.nasa.gov/about/tutorial/index.htm>
- IV&V Introductory Reading List at the IV&V Technical Library site - <http://library.ivv.nasa.gov>
- IEEE Std 1012-1998, IEEE Standard for Software Verification and Validation

Appendix D. Acronyms

AR	Acceptance Review
C/PAR	Corrective/Preventive Action Report
CAR	Corrective Action Request
CCHR	Catastrophic, Critical, High-Risk
CDR	Critical Design Review
CFL	Critical Function List
CI	Center Initiatives
CIM	Center Initiative Management
CM	Configuration Management

CO	Contracting Officer
CoFR	Certification of Flight Readiness
COTR	Contracting Officer Technical Representative
CSC	Computer Software Component
CSCI	Computer Software Configuration Item
CSIP	Center Software Initiative Proposal
CSU	Computer Software Unit
DCR	Document Change Request
DDD	Detailed Design Document
DDR	Detailed Design Review
DID	Data Item Description
DIT	Data Integration Team
DPM	Delegated Program Manager
DSR	Design Status Review
DVO	Detailed Verification Objective
EAC	Estimate at Completion
ECD	Expected Completion Date
FA	Formal Agreement
FAR	Federal Acquisition Regulation
FCA	Functional Configuration Audit
FQT	Formal Qualification Review
FRC	Federal Records Control
FRR	Flight Readiness Reviews
FSW	Flight Software
GFE	Government-Furnished Equipment
GMR	General Management Review
GPMC	Governing Program Management Council
GSFC	Goddard Space Flight Center
HSI	Hardware/Software Integration
IA	Independent Assessment
ICD	Interface Control Document
IDR	Integrated Design Review,
IFA	In-Flight Anomaly
IPR	In Process Review
IT&V	Integrated Test & Verification
ITA	Internal Task Agreement
IV&V	Independent Verification and Validation
JPL	Jet Propulsion Laboratory
JSRP	Joint Software Review Panel
L-2	Launch-Minus 2 Days
MOA	Memorandum of Agreement
MSFC	Marshall Space Flight Center

MSR	Monthly Status Review
NCR	Non Compliance Report
NOA	New Obligation Authority
NODIS	NASA Online Directives Information System
NPD	NASA Policy Directive
NPG	NASA Procedures and Guidelines
NRA	Nasa Research Announcement
NSRS	NASA Safety Reporting System
ORU	Orbital Replacement Unit
OSMA	Office of Safety and Mission Assurance
OSSMA	Office of Systems Safety and Mission Assurance
PALS	Program Automated Library System
PAR	Preventive Action Request
PCA	Physical Configuration Audit
PDR	Preliminary Design Review
PI	Principle Investigator
PIDS	Prime Item Development Specification
PM	Project Manager/Program Manager
PMR	Project Management Review
POC	Point Of Contact
POP	Program Operating Plan
PPL	Pre-Position Load
PR	Purchase Request
QA	Quality Assurance
QM	Quality Manual
QMS	Quality Management System
RFP	Request For Proposal
RMO	Resource Management Office
ROM	Rough Order of Magnitude
RTOS	Real-Time Operating System
S&MA	Safety & Mission Assurance
S/C	Space Craft
SAR	Startup Assessment Report
SARP	Software Assurance Research Program
SDD	Software Design Document
SDR	System Design Review
SE	Software Engineering
SLP	System Level Procedure
SMA	Safety and Mission Assurance
SOW	Statement Of Work
SPN	Station Program Notes
SQ	Software Quality Assurance

SRB	Software Review Board
SRR	System Requirements Review
SRS	Software Requirements Specification
SSR	Software Specification Review
STD	Software Test Description
STE	Special Test Equipment
SWG	Software Working Group
TIM	Technical Issue Memorandum
TO	Technical Officer
TRR	Test Readiness Review
UI	University Initiatives
USIP	University Software Initiative Proposal
WBS	Work Breakdown Structure